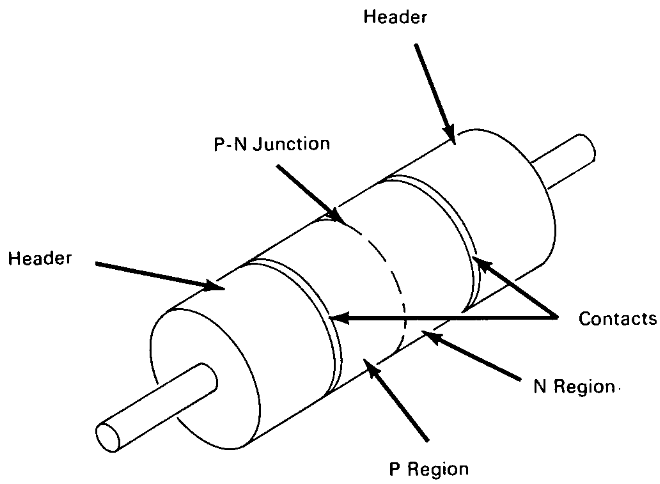
NASA TECH BRIEF

Silicon Carbide Diode for Increased Light Output



The electroluminescence spectrum of light-emitting diodes made of alpha-silicon carbide generally is confined to the range of 4500 to 6000 angstroms (from the blue to orange regions), with peak intensity occurring at about 5100 to 5200 angstroms (blue-green). A silicon carbide semiconductor device has been developed to improve the overall light output as well as the output in particular regions of the electroluminescent spectrum. The improvement in the electroluminescent behavior of silicon carbide is achieved by the introduction of transition metals, notably titanium, zirconium, or manganese. These impurities (not dopants in the usual sense) introduce levels that can be pumped electrically and affect the efficiency of the recombination process involved in emission of radiation.

The new device comprises a crystal of alpha-silicon carbide having a doped P-type region and a doped N-type region, separated by a P-N junction. The two doped regions are provided with relatively thin nonrectifying contacts, preferably comprising an alloy of gold and titanium. Heavy copper headers are soldered to these contacts. In addition to the dopants that determine the P- and N-type regions, the crystal also contains a selected transition metal. The latter may be present in all or only part of each or both of the P- and N-type regions; but at the very least the transition metal must be in the junction region. Although the junction is illustrated as abrupt, in practice it has a small width (no greater than 0.4 micron). The P-type semiconductivity is achieved by using as a dopant one or a mixture of the Group III elements (e.g., boron, gallium, aluminum). N-type semiconductivity is achieved by including in the crystal one or more Group V elements (e.g., antimony, arsenic, phosphorus). The device should have a carrier concentration of at least 10^{15} to 10^{19} atoms per cc. A device is activated to emission by applying a forward bias, as,

(continued overleaf)

for example, by connecting the headers to a source of dc of sufficient strength to cause the emission of radiation from the junction region. The exterior surface of the crystal should be polished to optical smoothness and exact perpendicularity to the plane of the junction in order to maximize the light that is emitted radially from the junction region. A convenient process for producing the silicon carbide devices is described in U.S. Patent 3,205,101.

Note:

No additional documentation is available. Inquiries may be directed to:

Technology Utilization Officer
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Reference: B69-10096

Patent status:

Title to this invention, covered by U.S. Patent No. 3,205,101, has been waived under the provisions of the National Aeronautics and Space Act (42 U.S.C. 2457 (f)), to Tyco Laboratories, Inc., Bear Hill, Waltham, Massachusetts 02154.

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